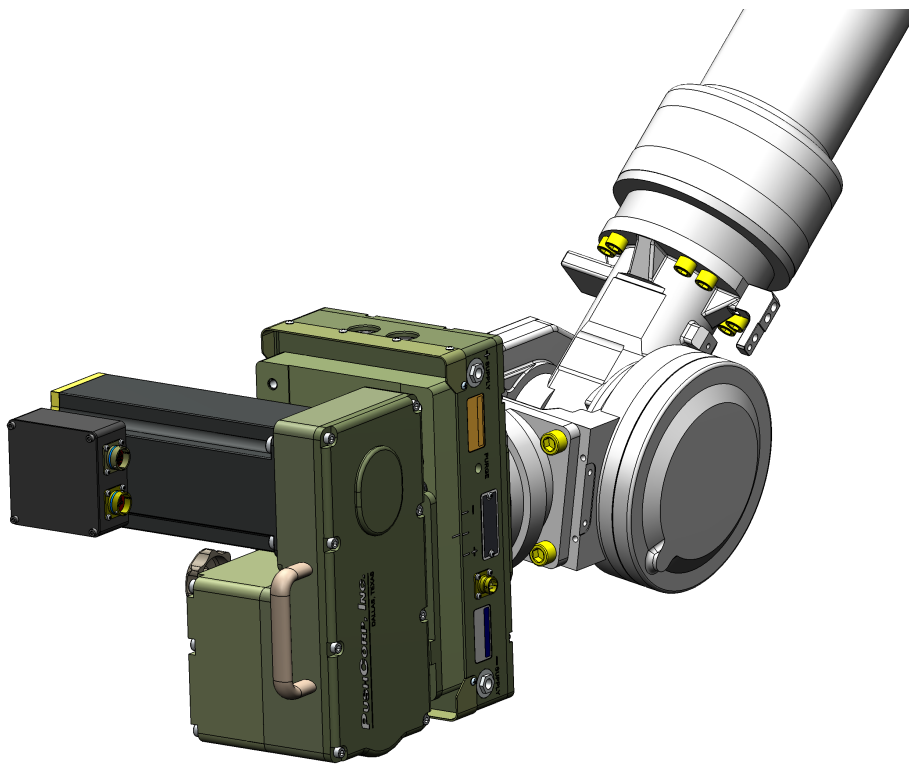


SWS100-3.7

Series Servo Weld Shavers



User Manual

PUSHCORP, INC.

Dallas, Texas

! DANGER !
REMOVE SERVO MOTOR
ELECTRICAL POWER
before replacing Slot Cutter inserts
or servicing weld shaver.

! WARNING !
SAFETY GLASSES ARE ALWAYS
REQUIRED
Insert breakage or shatter presents
great potential for eye injury.

All PushCorp, Inc. electrical cables are rated for high twist and flex robotic applications with a minimum cable bending radius specification of 125mm (5 in). Cable damage resulting from failure to abide by this specification will not be covered under warranty.

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1.0 Limited Warranty

Duration:

One year from date of delivery to the original purchaser.

Who gives this warranty (warrantor):

PushCorp, Inc.

Telephone: (972) 840-0208

Corporate Address:

P. O. Box 181915

Dallas, Texas 75218

Shipping Address:

3001 W. Kingsley Rd.

Garland, Texas 75041

Who receives this warranty (purchaser):

The original purchaser (other than for purposes of resale) of the *PushCorp, Inc.* product

What products are covered by this warranty:

Any *PushCorp, Inc.* industrial equipment or accessory supplied or manufactured by the Warrantor.

What is covered under this warranty:

Defects in material and/or workmanship which occur within the duration of the warranty period.

What is NOT covered in this warranty:

- A. IMPLIED WARRANTIES, INCLUDING THOSE OF MERCHANT-ABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE LIMITED TO ONE YEAR FROM THE DATE OF ORIGINAL PURCHASE. Some states do not allow limitations on how long an implied warranty lasts, so the above limitations may not apply to you.
- B. ANY INCIDENTAL, INDIRECT, OR CONSEQUENTIAL LOSS, DAMAGE or EXPENSE THAT MAY RESULT FROM ANY DEFECT, FAILURE, MALFUNCTION OF THE *PUSHCORP, INC.* PRODUCT. Some states do not allow the exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you.
- C. Any failure that results from an accident, purchaser's abuse, neglect, unauthorized repair or failure to operate the products in accordance with the instructions provided in the owner's manual(s) supplied with the product.

Responsibilities of the Warrantor under this warranty:

Repair or replace, at Warrantor's option, products or components which have failed within the duration of the warranty period.

Responsibilities of the purchaser under this warranty:

- A. Deliver or ship the *PushCorp, Inc.* product or component to PushCorp, Inc. Service Center, 3001 Kingsley Rd., Garland, TX 75041. Freight and insurance costs, if any, must be borne by the purchaser.
- B. Use reasonable care in the operation and maintenance of the product as described in the owner's manual(s).

When warrantor will perform repair or replacement under this warranty:

Repair or replacement will be scheduled and serviced according to the normal work flow at the service center, and depending on the availability of replacement parts. Purchasers requiring quicker repair may receive such with payment of a *PushCorp, Inc.* predetermined expediting fee.

This Limited Warranty gives you specific legal rights and you may also have other rights which vary from state to state.

2.0 General Overview

The *PushCorp, Inc.* SWS100-3.7 Series Servo Weld Shaver provides a fast and effective means to accurately remove excess material from a surface. The Weld Shaver is designed to remove random, inconsistent surface features such as seam welds, parting lines, and flashing, leaving behind a known, consistent, smooth surface. The SWS100-3.7 is ideal for use in applications where force-based, abrasive-only operations fail. Using the SWS100-3.7 can produce significant cost savings since one set of inserts can often out last hundreds of abrasive disks. A large selection of replaceable Carbide cutting inserts are used to literally peel metal away. The Weld Shaver/AFD combination forms a unique system where force control and positioning are used to perform accurate machining operations with a robot.

The SWS100-3.7 enables accurate surface machining by utilizing Tracking Wheels to follow over the part surface profile. An appropriate Adjustable Force Device is used to hold the Tracking Wheels firmly against the part surface. This arrangement allows the Weld Shaver to maintain contact with complex surfaces while compensating for any robot/part misalignment.

The SWS100-3.7 is comprised of two primary components: a Slot Cutter assembly, and a high torque Servo Motor.

The machining operation is performed by a 5 inch (125mm) diameter Sandvik Coromill® 331 Slot Cutter with replaceable Cutter Inserts. Each Slot Cutter is capable of machining a 20mm wide path. The SWS100-3.7 Series Weld Shavers may be configured with one, two, three, or four Slot Cutters allowing a width of cut ranging from 20mm to 79mm. The cutting depth of the Slot Cutter can be adjusted to any position from 0.1 inch (2.5mm) above the surrounding part surface to 0.1 inch (2.5mm) below.

A Servo Motor provides the power to turn the Slot Cutter, and allows precision adjustable speed control through a 0-10VDC analog interface. The SWS100-3.7 Series uses a 3.7 Horsepower motor with a speed range of 0 to 4000 RPM. The belt and pulley drive provides a 1.5:1 reduction ratio which reduces the speed and increases the output torque at the Slot Cutter. The Servo Motor allows the Weld Shaver to control Slot Cutter speed within 5%. The projected life of this high quality Servo Motor is over 30,000 hours.

Simple reliable construction combined with high torque, precision speed controlled servo technology make the *PushCorp* SWS100-3.7 Servo Weld Shaver a rugged, state-of-the-art technology capable of providing flexible, cost-effective weld machining operations.

3.0 Installation

3.1 Mounting the SWS100-3.7

The SWS100-3.7 Series Weld Shavers are designed to be attached to the carriage of a *PushCorp* AFD1100/80 via an Adapter Plate (SWS100-3.7-20mm, SWS100-3.7-39mm, SWS100-3.7-59mm). The SWS100-3.7-79mm is designed to bolt directly to an AFD1200/90 Adjustable Force Device. Figure 1 and Figure 2 below illustrate how these units are mounted to the AFD Carriage.

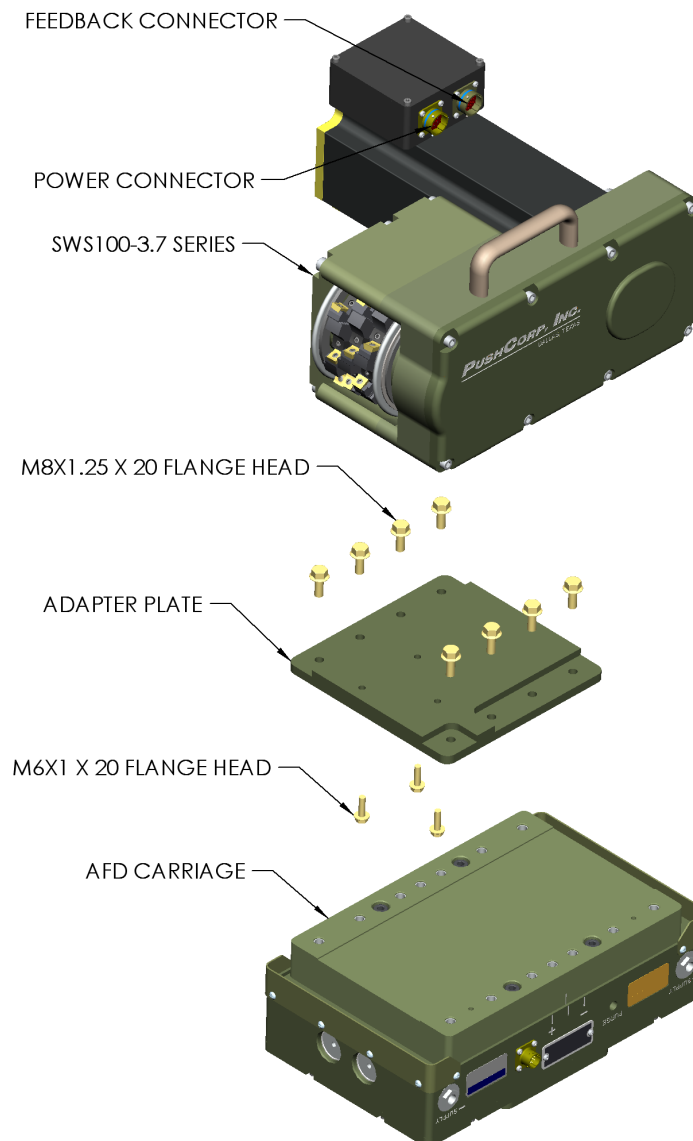


Figure 1. Mounting the SWS100-3.7-20, SWS100-3.7-39 and SWS100-3.7-59

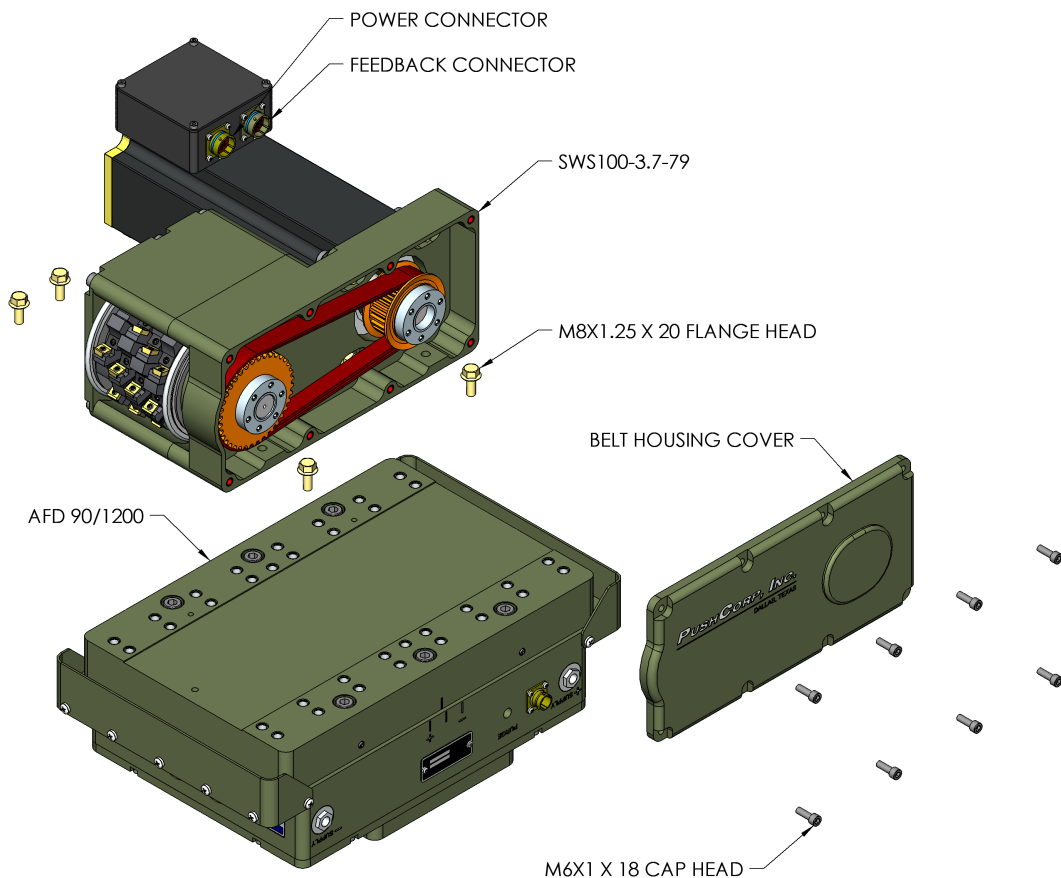


Figure 2. Mounting the SWS100-3.7-79mm

The SWS100-3.7 attaches to the AFD Carriage with M8x1.25 flange-head fasteners provided by *PushCorp*. Refer to Figure 1 and Figure 2 for the proper location of the fasteners.

CAUTION: If alternate fasteners are used make sure they do not exceed a depth of 0.525 inch (13.3 mm) into the AFD Carriage or damage can occur.

The Adapter Plate can be extended beyond the end of the carriage to allow more clearance. In this case only six M8 fasteners would be required to secure the plate to the carriage.

3.2 Electrical Connections

To use the SWS100-3.7 Series Weld Shavers it is necessary to connect the Servo Power, and Servo Feedback cables correctly. The servo amplifier is pre-configured to accept a 0 – 10VDC analog command velocity signal and a 24VDC digital signal to enable the motor. These are the only two signals that are required for operation and no other configuration is required to operate the motor. Other more advanced features are available and may be configured by referring to the supplied servo amplifier documentation.

4.0 Operation

4.1 Setting the Depth of Cut

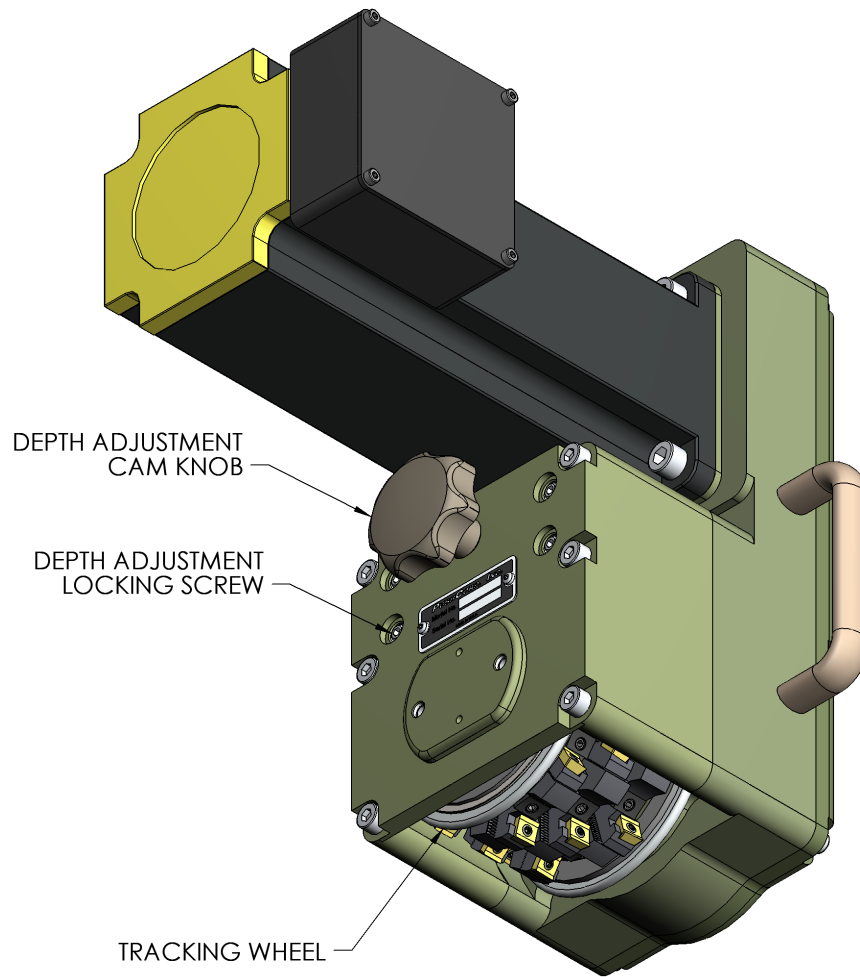


Figure 3. Depth-of-cut Adjustment

Adjusting the Weld Shaver's depth of cut is accomplished by raising or lowering the Tracking Wheels (Figure 3). Raising the Tracking Wheels to the maximum position will result in an approximately 0.1 inch (2.5 mm) deep slot. Lowering the Tracking Wheels to their lowest position will cause the Slot Cutter to be offset approximately 0.1 inch (2.5 mm) above the surface. Adjusting the Tracking Wheels to the middle position will produce a cut that is flush with the surface.

CAUTION: Remove all power from the Servo Motor before performing any adjustments to the SWS100-3.7 Series Weld Shaver.

To adjust the depth of cut, first loosen the four (4) Depth Adjustment Locking Screws approximately 1/4 turn.

CAUTION: It is required that the Depth Adjustment Locking Screws are released before the Depth Adjustment Knob is rotated. Failure to release the Depth

Adjustment Locking Screws can damage the mechanism and require the unit to be returned to the factory service center for a *non-warranty* repair.

Rotate the Depth Adjustment Cam Knob to move the Tracking Wheels relative to the Slot Cutter. Rotating the Depth Adjustment Knob one complete revolution will result in the Tracking Wheels moving 0.2 inches (5mm). A straight edge can be placed on the Tracking Wheels to position the Cutter Inserts to cut flush with the surface. In other cases it is most expeditious to approximate the initial setting and fine tune the Tracking Wheel position with sample passes. Once a depth-of-cut has been selected, the four (4) M8 Depth Adjustment Locking Screws should be re-tightened to the torque specified in Section 7.0 before beginning machining operations.

4.2 Setting Feeds and Speeds

Speed and Feed are important factors to consider for best results in milling. Improper Feed and Speed often cause low production, poor work quality and unnecessary wear to the inserts. In milling, Cutter Speed is measured in peripheral feet per minute, (revolutions per minute times the Slot Cutter circumference in feet). This will be referred to as the Cutter Speed here. In general use lower Cutter Speeds for hard materials, tough materials, abrasive materials, heavy cuts and maximum insert life. Use higher Cutter Speeds for: softer materials, light cuts, better finishes, maximum production rates. Table 1 gives approximate starting Cutter Speed values for some common materials. Additional information can be found in *Machinery's Handbook* or from the Insert manufacturer (<http://www.sandvik.com>).

Work Material	Cutter Speed (ft./min.)
Aluminum	1000
Silicon Bronze	1500
Cast Iron	300
Steel	450

Table 1. Cutter Speed for various materials.

Feed is usually measured in inches per minute. It is the product of Feed per Cutter Insert times revolutions per minute times the number of Inserts in the Slot Cutter. Feed per Cutter Insert affects chip thickness which is a very important factor in Insert life. Very thin, or feather-edge chips dull cutting edges more rapidly than thick chips. In general, the highest possible Feed per Cutter Insert will usually produce longer Insert life. However, excessive Feeds may also overload the Cutter Inserts and cause breakage or chipping of the cutting edge. Excessive feed can also cause the shaver motor to stall or the servo amplifier to fault.

As a guideline, use higher Feeds for: heavy, roughing cuts, easily machined materials, high tensile strength materials, abrasive materials. Use lower Feeds for: light and finishing cuts, difficult to machine materials, low tensile strength materials. A typical Feed per Cutter Insert for the SWS100-3.7 is 0.005 inches (0.12 mm). The Robot Feed Rate is the speed that the robot moves the Weld Shaver across the part in inches per minute.

$$\text{Servo Motor RPM} = \text{Cutter Speed (ft/min)} \times 1.2 = (\text{Rev./min.}) \quad (\text{Eq. 1})$$

$$\text{Feed/Cutter Insert} = \frac{\text{Robot Feed Rate (in/min)}}{5.4 \times \text{Servo Motor RPM}} = (\text{in./Cutter Insert}) \quad (\text{Eq. 2})$$

$$\text{Robot Feed Rate} = 5.4 \times \text{Feed/Cutter Insert} \times \text{Servo Motor RPM} = (\text{in./min.}) \quad (\text{Eq. 3})$$

The above equations are provided to help determine initial settings for the Weld Shaver. Note that the Servo Motor rotates at 1.5 times the speed of the Slot Cutter. Each Slot Cutter has eight (8) identical inserts. This has been included in the equations above. These equations apply only to the SWS100-3.7 Weld Shaver and should not be used for any other machines.

To help illustrate the use of the equations, the following Example Problems are provided:

Example Problem (1)

Determine the Servo Motor RPM for a Steel weld seam.

Material: Steel → Cutting Speed = 450 (ft./min.) (See Table 1)

Servo Motor RPM = $450 \times 1.2 = 540$ (Rev./min.) (Eq. 1)

Example Problem (2)

Determine the Feed/Cutter Insert for a Robot Feed Rate of 20 (in./min.) and a Servo Motor RPM of 540 (Rev./min.).

Feed/Cutter Insert = $\frac{20}{5.4 \times 540} = 0.007$ (in./Cutter Insert) (Eq. 2)

Example Problem (3)

Determine the Robot Feed Rate based on a 0.007 (in./Cutter Insert) and a Servo Motor RPM of 540 (Rev./min.).

Robot Feed Rate = $5.4 \times 0.007 \times 540 = 20$ (in./min.) (Eq. 3)

4.3 Problems and Corrective Measures

Table 2 shows some of the more common troubles encountered and the recommended corrective measures involving variations in Cutter Speeds (Servo Motor RPM) and Feeds (Robot Feed Rate).

<i>Problem</i>	<i>Corrective Action</i>
Lack of rigidity (Robot Flexing)	Increase Cutting Speed, reduce Feed
Excessive abrasion on the insert	Reduce Cutting Speed, increase Feed
Chipping of the cutting edge	Reduce Feed/Cutter Insert
Burning of the cutting edge	Reduce Cutting Speed
Cratering of cemented carbide	Reduce Feed and Cutting Speed
Chatter	Try other combinations of Feed and Cutting Speed

Table 2. Troubles and Corrective Measures

4.4 Teaching the Weld Shaver Path

Teaching the path over the part surface is greatly simplified because of the force device's compliance. The force control carriage stroke of the AFD allows the Weld Shaver Guide Wheels to easily maintain consistent contact with the part surface. **Both Guide Wheels must maintain continuous contact with the part surface during the machining operation.**

The required AFD force is dependent on the application, however a 20 lbs. (89 N) applied force is usually a good starting point. If the force is too low, the Guide Wheels can rise from the surface and cause damage to the cutter inserts. Conversely, applying

too much force can cause the part surface to deflect or deform and places unnecessary loads on the Guide Wheels.

The Guide Wheels should straddle the weld seam to produce the best results. Remember, the Weld Shaver only follows the part surface. Therefore any dirt, contamination, or weld spatter will affect the final quality of the cut.

5.0 Slot Cutter and Inserts

The Slot Cutter provides for Cutter Insert location plus adjustable width and indexing capabilities. The Cutter Inserts are retained securely in position by Insert Screws which permit the Cutter Inserts to be “indexed”. A large selection of Cutter Inserts are available from Sandvik.

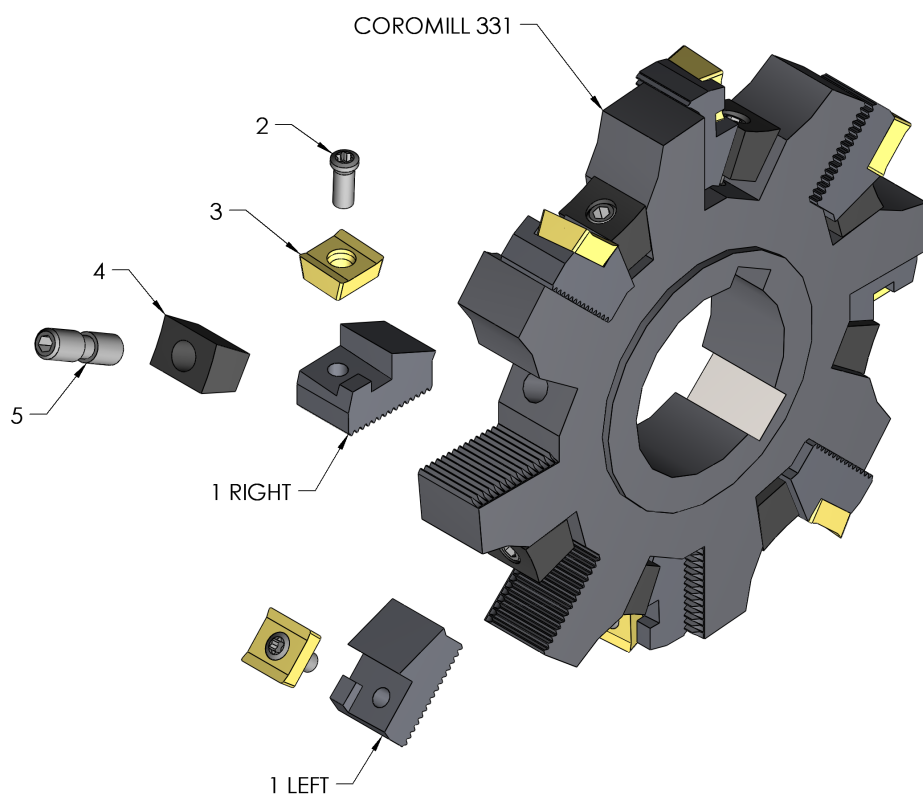


Figure 4. Slot Cutter Assembly

Item	Sandvik Part Number	Description
1 RIGHT	5321 240-07	RIGHT CASSETTE
1 LEFT	5321 240-08	LEFT CASSETTE
2	5513 020-29	INSERT SCREW
3	USER SELECTED	CUTTER INSERT
4	5431 105-04	WEDGE
5	339-831	WEDGE SCREW

DANGER: Remove all power from the Servo Motor before changing or indexing Cutter Inserts.

WARNING: Insure Wedge Screws are securely tightened into the Slot Cutter, before rotating with the Servo Motor.

Set up Procedure

1. Determine the correct insert for the material to be milled.
2. Remove the Insert Screw (2) shown in Figure 4 and install or index the dull Cutter Insert.
3. Insure that the Slot Cutter is Cassette Pocket (1) is clean.
4. Hand position the Cutter Insert (3) between in the Cassette.
5. Securely tighten the Insert Screw (2) with a torque of 26 lb.- in. (3 N·m). The Insert Screw is a type *Torx Plus 15IP*. The recommended *Sandvik* torque wrench is listed below.
6. Continue this process until all (8) eight Cutter Inserts are replaced or correctly indexed.

NOTE: Cutter Inserts can be indexed (i.e., rotated) 180°.

Cutter Insert Screw torque wrench:

Sandvik P/N: 5680 100-06 (Torx Plus)

Wedge Screw Key:

Sandvik P/N: 265.2-817 (3.0mm)

Cutter Inserts:

Sandvik ordering code: N331.1A-11 50

6.0 Maintenance

6.1 Replacing the Drive Belt

The Drive Belt used in the Weld Shaver transfers power from the Servo Motor to the Slot Cutter. The Drive Belt has been sized to handle the largest possible peak Servo Motor torque, so that fatigue will most likely be the cause of any belt failure. It is not unusual for a belt of this type to perform for thousands of hours, however actual performance is highly dependent on the application.

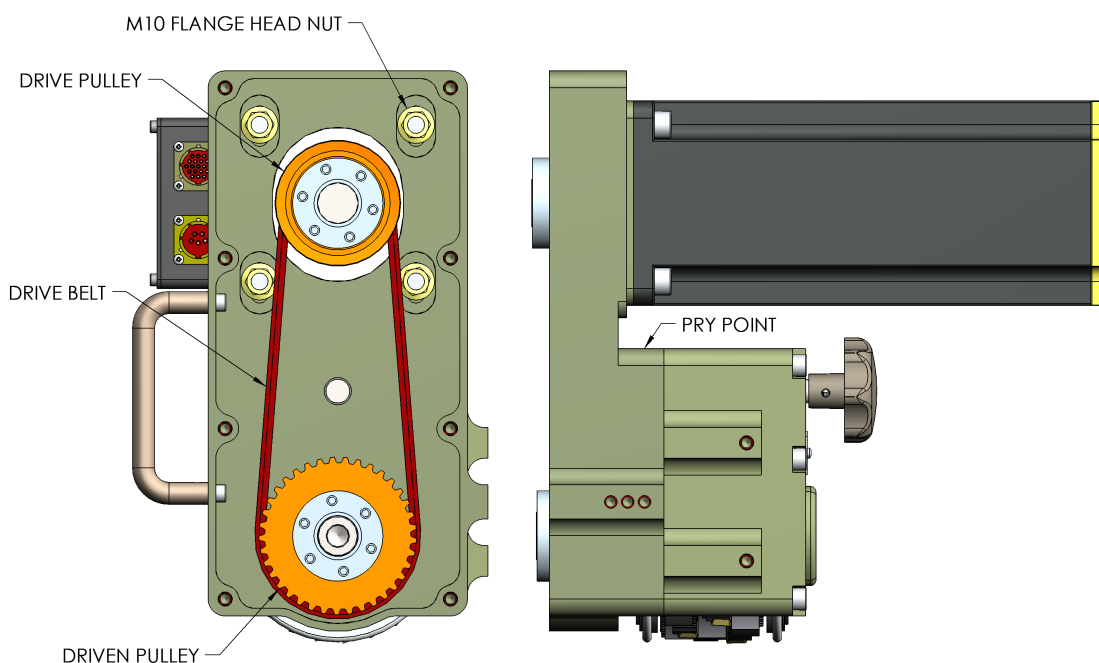


Figure 5. Replacing the Drive Belt

One of the benefits of synchronous belt drives is lower belt pretensioning in comparison to other belt drives. However, proper installation tension is still important in achieving the best possible performance. In general terms, belt tensioning is needed for proper belt/pulley meshing to prevent belt ratcheting under peak loading.

DANGER: Remove all power from the Servo Motor before servicing the SWS100-3.7 Weld Shaver.

Drive Belt Replacement Procedure

1. Remove the (8) eight M6x1 Socket Head Cap Screws securing the Belt Cover to provide access to the Drive Belt. See Figure 2.
2. Loosen the (4) four M10x1.5 Flange Head Nuts, shown in Figure 5, approximately $\frac{1}{4}$ turn. This will allow the Servo Motor to move, but constrain the Drive Pulley to remain essentially parallel to the Driven Pulley during tensioning.
3. Move the Servo Motor in the slots toward the Driven Pulley. This is the shortest distance between the two pulleys.

4. Slide the Drive Belt off the Driven Pulley (no flanges) until it is clear, and slip the Drive Belt off of the Drive Pulley.
5. To install the new Drive Belt, first place it over the Drive Pulley and then slide it over the Driven Pulley. It is absolutely critical that the belt teeth are correctly meshed with the teeth on both of the pulleys. This is accomplished by moving the Servo Motor away from the Driven Pulley while rotating the pulleys in opposite directions by hand.
6. Proceed to Section 6.2 to set the proper Drive Belt tension.

6.2 Setting the Proper Drive Belt Tension

Applying the proper Drive Belt tension is a very important factor in the life of the Drive Belt and the Servo Motor. Too little tension will allow the Drive Belt to jump teeth on the pulleys. Too much tension will cause premature failure of the Servo Motor bearings. The Weld Shaver requires tension in each belt segment of 118 lbs. (525 N) for a new belt, and 101 lbs. (450 N) for a used belt, which results in a separation force of 235 lbs. (1045 N) and 200 lbs. (892 N), respectively, between the Drive and Driven Pulleys.

The main problem with tensioning the Drive Belt is accurately applying the required separation force with tools readily available on the factory floor. Placing a Pry Tool on top of the Cutter Housing and underneath the mid-point of the Servo Motor flange. The pry bar location is shown in Figure 5 as the pry point. This allows the Drive Belt to be easily tensioned. The lever/fulcrum creates a force multiplier.

With the Weld Shaver in the vertical position, as shown in Figure 5, the proper Tension Force at 15 inches (381 mm) will be 20 lbs. (87 N) for a new belt, and 17 lbs. (74 N) for a used belt. Once the proper Tension Force has been applied, tighten the (4) four M10 Flange Head Bolts to the torque specified in Section 7.0. Replace the Belt Cover and re-install the (8) eight M6 Socket Head Cap Screws. Tighten the M6 Socket Head Cap Screws to the torque specified in Section 7.0.

CAUTION: Never operate the SWS100-3.7 Weld Shaver without the Belt Cover properly installed.

7.0 Specifications

TOOL WEIGHT:

SWS100-3.7-20: 60 lbs. (27 kg)

SWS100-3.7-39: 67 lbs. (30 kg)

SWS100-3.7-59: 75 lbs. (34 kg)

SWS100-3.7-79: 85 lbs. (39 kg)

MOTOR SPECIFICATIONS:

Power: 4.8 Hp (3.6 kW)

Continuous Cutter Torque: 15.6 lb-ft (14.7 N·m)

Maximum Cutter RPM: 2800 RPM

Motor to Cutter Belt Ratio: 1.5:1

Supply Voltage: 208-480 VAC, 3Φ, 50 / 60 Hz

Drive Belt Specification: Gates P/N 8MGT-640-21

Requires separate power supply, amplifier and cables.

CUTTER SPECIFICATIONS:

Manufacturer: Sandvik 331 Coromill

Insert Size: 11

Insert Style: N331.1A-11 50

Diameter: 4.9 inch (125mm)

No. Inserts: 8

Cutting Width: 20mm, 39mm, 59mm, 79mm

For specific dimensions see <http://www.pushcorp.com> for detail drawings.

Specifications subject to change without notice.

Fastener Tightening Torque Specs					
Fastener Size	Torque			Minimum Depth	
	in.-lbs.	ft.-lbs.	N·m	in.	mm
M4 x .7	50	4.2	5.6	0.17	4.3
M5 x .8	85	7.1	9.6	0.21	5.3
M6 x 1	140	11.7	15.8	0.25	6.3
M8 x 1.25	348	29.0	39.3	0.33	8.4
M10 x 1.5	600	50.0	67.8	0.41	10.5